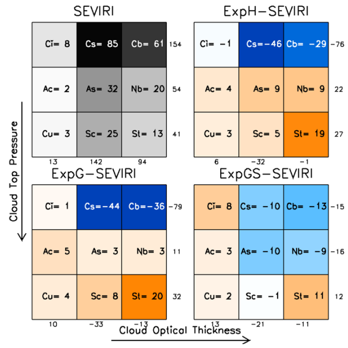
Evaluation of Cloud Properties and Precipitation for Stratiform and Convective Simulations

Research Highlight

Operational Numerical Weather Prediction (NWP) models now routinely use explicit deep convection, so that all simulated surface precipitation (stratiform and convective) originates from the microphysical parameterization. Previous work has shown that simulations of frontal stratiform precipitation events are sensitive to the representation of snow in the cloud microphysics parameterization, while convective precipitation events are mainly sensitive to the representation of the largest rimed ice species (either graupel or hail). In operational NWP, a single model-setup is required, and therefore it is important to understand how model modifications designed to improve moist processes under certain synoptic conditions affect simulations during different conditions.

Microphysics sensitivity experiments of the representation of snow and the rimed ice species were applied to two composites of 15 stratiform and 15 convective observed precipitation events. Within each composite, the simulation setup is the same, with the exception for the treatment of the rimed species. Cloud properties and surface precipitation characteristics of all events were rigorously evaluated against satellite- and radar-derived observations. The satellite evaluations involved the use of ISCCP-like cloud classifications, where cloud classes were based on cloud optical thickness and cloud-top pressure. The composite approach allows combining the statistical significance of long-term evaluations with the detailed physical understanding from case studies.

It was found that the cloud optical thickness distribution was well-captured by all experiments, although a significant underestimation of cloudiness occurred in the convective composite. Simulations that include graupel and a temperature-dependent snow intercept parameter during both convective and stratiform events yielded ISCCP-cloud classifications that consistently agreed better with satellite observations. The cloud-top-pressure distribution was improved most by more realistic snow size distributions (including a temperature-dependent intercept parameter and non-spherical snow for the calculation of the slope parameter), due to increased snow depositional growth at high altitudes. Compared to previous idealized experiments, surface precipitation was less sensitive to whether graupel or hail was chosen as the rimed ice specie. However, including graupel in convective and stratiform events consistently yielded better peak precipitation rates compared to observed precipitation rates from a radar-rain gauge combined product.



Evaluation of the stratiform composite. (Top left) Area covered per ISCCP-like cloud class as observed by SEVIRI (in 10^3 km^2). Area differences from SEVIRI are given for simulations where the rimed ice species is hail (ExpH), graupel (ExpG), or graupel with the snow size distribution varying with temperature (ExpGS). Cloud classes are: cirrus (Ci), cirrostratus (Cs), cumulonimbus (Cb), altocumulus (Ac), altostratus (As), nimbostratus (Nb), cumulus (Cu), stratocumulus (Sc) and stratus (St).

Reference(s)

Van Weverberg K, NP van Lipzig, L Delobbe, and AM Vogelmann. 2012. "The role of precipitation size distributions in km-scale NWP simulations of intense precipitation: evaluation of cloud properties and surface precipitation." Quarterly Journal Royal Meteorological Society, 138, doi:10.1002/qj.1933.

Contributors

Kwinten Van Weverberg, *Brookhaven National Laboratory*; Andrew M. Vogelmann, *Brookhaven National Laboratory*

Working Group(s)

Cloud Life Cycle